CLAIMS

1. A catalyst for addition polymerisation of olefinically unsaturated monomers comprising:

a) A first compound

MY

where: M is a transition metal in a low valency state or a transition metal in a low valency state co-ordinated to at least one co-ordinating non-charged ligand.

Y is a monovalent divalent or polyvalent counterion;

b) An initiator compound comprising a homolytically cleavable bond with a halogen atom; and

c) An organodiimine, where at least one of the nitrogens of the diimine is not part of an aromatic ring.

2. A catalyst for addition polymerisation of olefinically unsaturated

monomers comprising:

d) A first component of Formula

$[ML_m]^{n+} A^{n-}$

where: M = a transition metal of low valency state

L = an organodiimine where at least one of the nitrogens of the diimine is not a part of an aromatic ring.

A = an anion

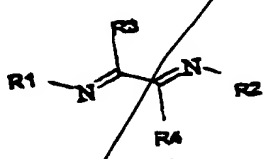
n = an integer of 1 to 3

m = an integer of 1 to 2, and

e) An initiator compound comprising a homolytically cleavable bond with a halogen atom.

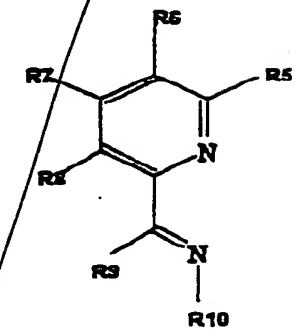
7. A catalyst according to ~~any previous claim~~ claim 1 wherein the organodiimine is selected from:

a 1,4-diaza-1,3-butadiene



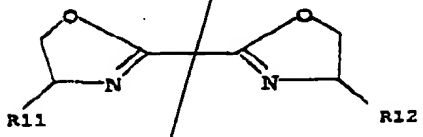
Formula 24

a 2-pyridine carbaldehyde imine



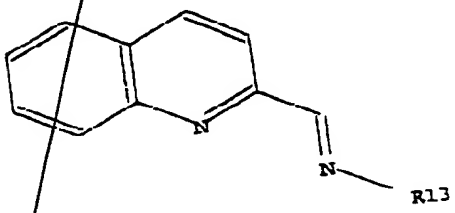
Formula 25

an oxazolidone



Formula 26

or a quinoline carbaldehyde



Formula 27

where:

R_1, R_2, R_{10}, R_{11}, R_{12} and R_{13} are independently selectable and may be selected from H, straight chain, branched chain or cyclic saturated alkyl, hydroxyalkyl, carboxyalkyl, aryl, CH_2 Ar (where Ar is aryl or substituted) or a halogen;

R_3 to R_9 are independently selectable and may be selected from H, straight chain, branched chain or cyclic alkyl, hydroxyalkyl, carboxyalkyl, aryl, CH_2 Ar, a halogen, OCH_{2n+1} (where n is an integer of 1 to 20), NO_2, CN, O = CR (where R = alkyl, aryl, substituted aryl, benzyl $PhCH_2$ or a substituted benzyl).

4. A catalyst according to claim 3 wherein R_1 to R_{13} are selected from the group consisting of C_1 to C_{20} alkyl, C_1 to C_{20} hydroxyalkyl, C_1 to C_{20} carboxyalkyl, n-propylisopropyl, n-butyl, sec-butyl, tert-butyl, cyclohexyl, 2-ethylhexyl, octyldecyl ~~or~~ and lauryl.

5. A catalyst according to claim 3 ~~or claim 4~~, wherein the organodiimine comprises a chiral centre.

6. A catalyst according to ~~claims 3 to 5~~ claim 3 wherein one or more adjacent R_1 and R_3, R_3 and R_4, R4 and R_2, R_{10} and R_9, R_8 and R_9, R_8 and R_7, R_7 and R_6, R_6 and R_5 groups are selected from the group consisting of alkyl, cycloalkenyl, polycycloalkyl, polycycloalkenyl ~~or~~ and cyclicaryl, containing 5 to 8 carbon atoms.

48 claim 1

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11. A catalyst according to ~~any previous claim~~ wherein M is selected from the group consisting of Cu(I), Fe(II), Co(II). Ru(II), Ni(II) Sm(II), Ag(I) and Yb(II).

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8. A catalyst according to ~~any of claims 1 and 3 to 7~~ claim 1, wherein Y is selected from the group consisting of Cl, Br, I, NO_3, PF_6, BF_4, SO_4 and CF_3SO_3, CN, SPh, ScN and SePh.

9. A catalyst according to ~~any of claims 2 to 7~~ claim 2 whcrein A is selected from: Cl, Br, F, I, NO_3, SO_4 and ~~CuX_2~~ (where X is a halogen).

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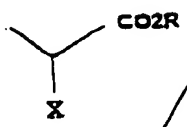
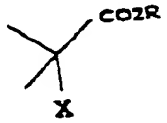
10. A catalyst according to ~~any previous claim~~ claim 1, wherein the initiator is selected from:

RX

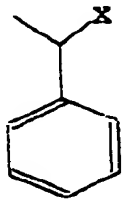
Formula 2



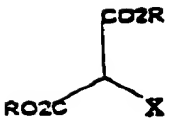
Formula 3



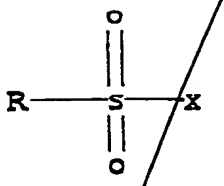
Formula 4



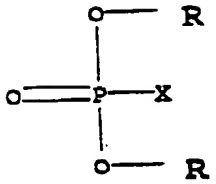
Formula 5



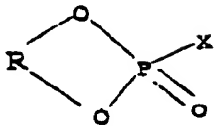
Formula 6



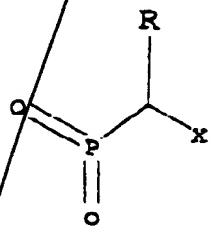
Formula 7



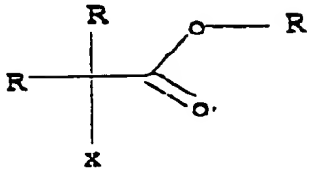
Formula 8



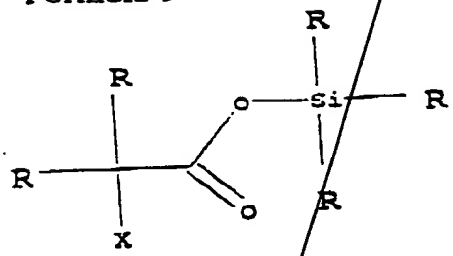
Formula 9



Formula 10



Formula 11

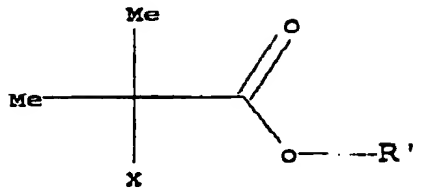


Formula 12

where R is independently selectable and is selected from straight chain alkyl, branched chain alkyl, cyclic alkyl, hydrogen, substituted alkyl, hydroxyalkyl, carboxyalkyl, aryl and substituted aryl and substituted benzyl.

X = a halide

11. A catalyst according to claim 10, wherein the initiator is



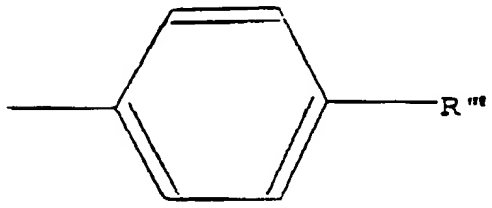
wherein

X = Br, I or Cl, ~~preferably Br~~

R' = -H,

$-(CH_2)_pR''$, (where p is a whole number and R'' = H, OH, NH_2, SO_3H, COOH, halide, COX, where X is Br, I or Cl),

or



$R''' = -COOH$, -COX, (where X is Br, I or Cl), -OH, $-NH_2$ or $-SO_3H$.

12. A catalyst according to claim 11 wherein b is 2-hydroxyethyl-2' bromopropionate.

13. The use of a catalyst according to ~~any previous claim~~ claim 1 in the

addition polymerisation of one or more olefinically saturated monomers.

14. The use of a catalyst according to claim 13 at a temperature between -20°C to 200°C.

15. The use of a catalyst according to claim 14 between 20°C and 130°C.

16. The use of a catalyst according claims 13 to 15, wherein the olefinically saturated monomer is selected from methyl methacrylate, ethyl methacrylate, propyl methacrylate (all isomers), butyl methacrylate (all isomers), and other alkyl methacrylates; corresponding acrylates; also functionalised methacrylates and acrylates including glycidyl methacrylate, trimethoxysilyl proply methacrylate, allyl methacrylate, hydroxyethyl methacrylate, hydroxypropyl methacrylate, dialkylaminoalkyl methacrylates; fluoroalkyl (meth)acrylates: methacrylic acid, acrylic acid; fumaric acid (and esters), itaconic acid (and esters), maleic anhydride; styrene, α-methyl styrene: vinyl halides such as vinyl chloride and vinyl fluoride; acrylonitrile, methacrylonitrile; vinylidene halides of formula $CH_2 = C(Hal)_2$ where each halogen is independently Cl or F; optionally substituted butadienes of the formula $CH_2 = C(R^{15})\ C(R^{15}) = CH_2$ where

R^{15} is independently H, C1 to C10 alkyl, Cl, or F; sulphonic acids or derivatives thereof of formula $CH_2 = CHSO_2OM$ wherein M is Nas, K, Li, $N(R^{16})_4$, R^{16}, or $-(CH_2)_2$-D where each R^{16} is independently H or C1 or C10 alkyl, D is CO_2Z, OH, $N(R^{16})_2$ or SO_2OZ and Z is H, Li, Na, K or $N(R^{16})_4$; acrylamide or derivatives thereof of formula $CH_2 = CHCON(R^{16})_2$, and methacrylamide or derivatives thereof of formula $CH_2{=}C(CH_3)CON(R^{16})_2$. Mixtures of such monomers may be used.

17. The use of a catalyst, as defined in claims 1 and 3 to 12, according to claims 13 to 16, wherein the ratio (c):(a) is 0.01 to 1000 and the ratio of (a):(b) is 0.0001 to 1000.

18. The use of a calalyst as defined in claims 2 to 12 according to claims 13 to 16 wherein the ratio of M:initiator is between 3:1 and 1:100.

19. The use of catalyst according to ~~claims 13 to 16~~ claim 13, where the polymerisation is undertaken in water, a protic or non-protic solvent.

20. The use of a catalyst according to ~~claims 1 to 12~~ claim 1 to produce a statistical copolymer, a block copolymer, a telechelic polymer or a comb and graft copolymer of monomers according to previous claim.